

# **A New Record of *Microarthridion littorale* (Copepoda, Harpacticoida, Tachidiidae) from Korea with Taxonomic Note on the Species**

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## **ABSTRACT**

A harpacticoid copepod, *Microarthridion littorale* (Poppe, 1881), is newly recorded in Korea. *Microarthridion* species can be distinguished from each other by a combination of the number of the antennular segment, the number of the seta on the antennary exopod, and the armature of the thoracopod legs. Korean materials examined coincide well with *M. littorale* on these well-known characteristics. However, there are some minor differences in the ornamentations of the maxilliped and swimming legs. The specimens show additional sexual dimorphisms in the setae on enp-3 of P1 and exp-3 of P2–P4. Morphological diversity of so-called *M. littorale* is also discussed here with detailed features.

**Keywords:** *Microarthridion littorale*, Harpacticoida, Korea, new record, Tachidiidae, taxonomy

## **INTRODUCTION**

The family Tachidiidae Boeck, 1896 is a small group comprising 16 species of six genera (Tran and Chang, 2012). They are mainly characterized by nuchal organs, reduced setation of the maxilliped, and a single plate-like P5 in both sexes (Seifried, 2003). They inhabit mainly benthic from euryhaline environment (Chang, 2008). From Korean brackish waters, the following five species belonging to this family have been described: *Tachidius discipes* Giesbrecht, 1881, *Geopsis incisipes* (Klie, 1913), *Microarthridion litospinatus* Shen and Tai, 1973, *Neotachidius parvus* Huys et al., 2005, and *N. coreanus* Huys et al., 2005 (Huys et al., 2005; Chang, 2008). Song and Chang (1995) have reported *Tachidius* (*Neotachidius*) *triangulris* Shen and Tai, 1963. It is synonymized as *N. parvus* by Chang (2008) with a key to species of the family from Korean waters.

Within the family Tachidiidae, the genus *Microarthridion* Lang, 1944 is the largest group currently containing nine species: *M. littorale* (Poppe, 1881), *M. reductum* (Monard, 1935), *M. berberum* (Monard, 1936), *M. laurenticum* (Nicholls, 1940), *M. fallax* Perkins, 1956, *M. perkinsi* Bodin,

1970, *M. litospinatus* Shen and Tai, 1973, *M. corbisierae* Kihara and Rocha, 2007, and *M. thanhi* Tran and Chang, 2012 (World Register of Marine Species, 2015). They were mainly recorded from the northern hemisphere except for *M. corbisierae* which was described from Brazil (Huys et al., 2005; Kihara and Rocha, 2007). In East Asia, two *Microarthridion* species have been reported. *Microarthridion littorale* was recorded from China and Russia (Suifen Ho), and *M. litospinatus* was reported from China and Korea (Borutsky, 1952; Shen and Tai, 1973; Tai and Song, 1979; Chang, 2008).

During a study on harpacticoid fauna of Korea, the authors encountered specimens of *M. littorale*, the type species of the genus, from intertidal mudflat in the southwest coast of Korea. In the present study, we report this species as a new member to Korean fauna with detailed description and illustrations. We also discussed the morphological diversity of so-called *M. littorale* with detailed characteristics.

## **MATERIALS AND METHODS**

Samples were collected from mudflat of intertidal zone by

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using a 63 µm mesh size sieve. Specimens were fixed initially with 99.9% ethyl alcohol. Before dissection, habitus was drawn and observed from whole specimens mounted in lactophenol. Their appendages were dissected using tungsten needles under a stereomicroscope (Discovery. V8; Carl Zeiss, Göttingen, Germany). Each appendage and urosome were mounted in lactophenol on slides and sealed with Canada balsam. All line drawings were made using a drawing tube attached to a light microscope (Olympus BX53; Olympus, Tokyo, Japan) equipped with differential interference contrast. Materials examined in this study were deposited at the National Institute of Biological Resources (NIBR), Incheon, Republic of Korea.

The terminology for description follows that of Huys and Boxshall (1991). Abbreviations used in the text are as follows: P1–P6, first to sixth thoracopods; exp(enp)-1 (-2, -3), the proximal (middle, distal) segment of ramus.

## SYSTEMATIC ACCOUNTS

Order Harpacticoida Sars, 1903

Family Tachidiidae Boeck, 1865

Genus *Microarthridion* Lang, 1944

<sup>1</sup>\**Microarthridion littorale* (Poppe, 1881) (Figs. 1–6)

*Tachidius littoralis* Poppe, 1881: 149, Pl. 6, figs. 1–12; Canu, 1892: 156; Klie, 1913: 36, figs. 18–19; Willey, 1929: 536, fig. 28; Gurney, 1932: 32, figs. 411–428; Pesta, 1932: 24, figs. 18–19; Borutsky, 1952: 104, fig. 36: 1–12.

*Tachidius crassicornis* Scott, 1892: 250, Pl. 8, figs. 14–27.

*Microarthridion littorale* Lang, 1948: 295, Abb. 144: 1; Dussart, 1967: 177, fig. 63; Apostolov and Marinov, 1988: 82, fig. 25: 2a–6; Huys et al., 1996: 226, fig. 89; Kornev and Chertoprud, 2008: 91.

?*Microarthridion littorale*: Tai and Song, 1979: 176, fig. 92.

**Material examined.** South Korea: 4 ♀♀, 2 ♂♂, Jeollanam-do, Jindo-gun, Uisin-myeon, Chosa-ri (34°24'55.55"N, 126°19'32.59"E) on 3 May 2015; 1 ♀ (NIBRIV0000470365) dissected on 14 slides; 1 ♂ (NIBRIV0000470366) dissected on eight slides; 1 ♀ (NIBRIV0000470367) dissected on seven slides; 1 ♂ (NIBRIV0000470368) dissected on eight slides; 1 ♀ (NIBRIV0000470369) dissected on nine slides; 1 ♀ (NIBRIV0000470370) dissected on 13 slides.

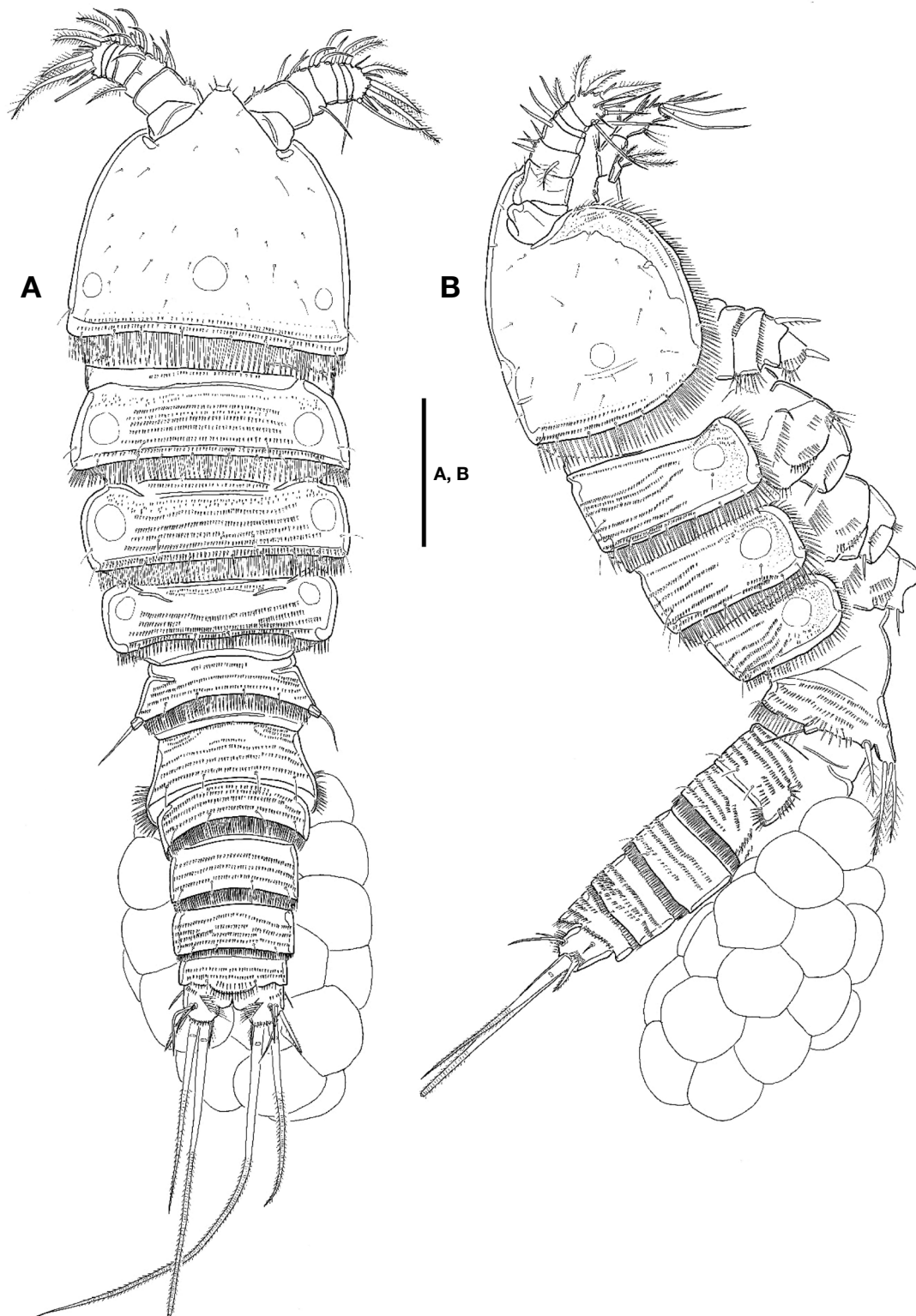
**Description. Female:** Body (Fig. 1A, B) fusiform tapering posteriorly, with distinct boundary between prosome and urosome; total length from 660.0 to 716.7 µm (mean 690

µm, n=4) including rostrum and caudal rami; surface of each somite armed with rows of minute spinules except for cephalothorax and caudal rami; posterior margin of each somite except for caudal rami armed with spinules; pleuron of each pedigerous prosomite armed with spinules. Rostrum (Fig. 2A) triangular in shape, fused to cephalothorax at its base, with 2 sensilla subapically; anterior tip blunt, with ventral protrusion bearing 2 sensilla. Cephalothorax (Fig. 1A, B) as long as wide in dorsal view, with row of spinules along posterior and anteroventral margins; surface covered with paired sensilla, with 3 nuchal organs posteriorly. P1-bearing somite incorporated into cephalothorax. Each pedigerous prosomite (Fig. 1A, B) with paired nuchal organs on lateral surface; surface with 2 pairs of sensilla except for P4-bearing somite; each posterior and anteroventral margins with 10, 8, and 2 pairs of sensilla, respectively. Urosome (Fig. 2B) slender than prosome, tapering posteriorly. P5-bearing somite (Fig. 1A, B) trapezoidal, with 2 pairs of sensilla on surface. Genital double-somite (Figs. 1A, B, 2B) slightly shorter than wide in dorsal view, fused ventrally but separated dorsolaterally by suture; genital somite with 2 pairs of sensilla on posterior margin and well-developed pleuron bearing rows of spinules; urosomite 3 narrower than genital somites, with 2 pairs of sensilla on posterior margin. Genital field (Fig. 2C) having common median genital slit without seta; single copulatory located posterior to genital slit and covered by cuticula process. Urosomite 4 with stout spinules on both posterolateral surfaces; posterior margin with 2 pairs of sensilla dorsally and 1 pair of sensilla ventrally. Urosomite 5 slightly smaller than preceding one, with 2 pairs of sensilla on posterior margin. Anal somite (Figs. 1A, B, 2B) small; dorsal surface with 1 pair of sensilla; ventral surface with 1 row of spinules and 1 pair of sensilla; posterior margin armed with row of spinules ventrally; anal operculum weakly developed, semicircular, with 1 row of fine setules along posterior margin; anal opening ornamented with several rows of fine setules.

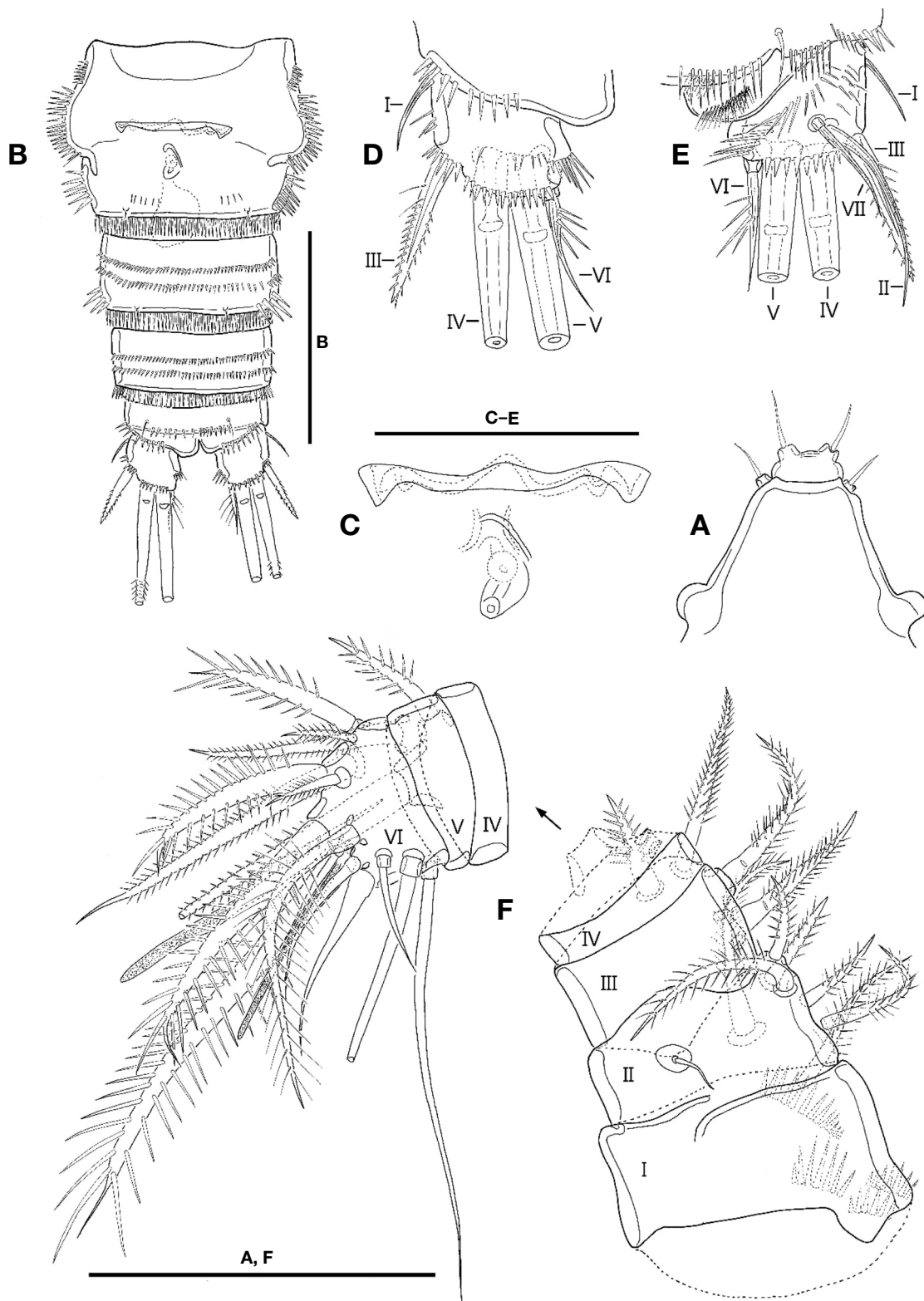
Caudal rami (Fig. 2D, E) as long as wide in ventral view, with 1 oblique row of setules on dorsomedial surface medially and several minute spinules on dorsal and lateral surfaces, and armed with 7 setae. Seta I small, located on lateral surface proximally. Seta II long, slender, and located on dorsal surface, near seta VII. Seta III spiniform, pinnate, longer than caudal ramus in length. Setae IV and V well-developed, pinnate distally; seta V 1.5 times as long as seta IV. Seta VI slender, small, slightly shorter than seta III and bearing setules. Seta VII articulated, slender, as long as seta III.

Antennule (Fig. 2F) short, blunt, 6-segmented; segment 1

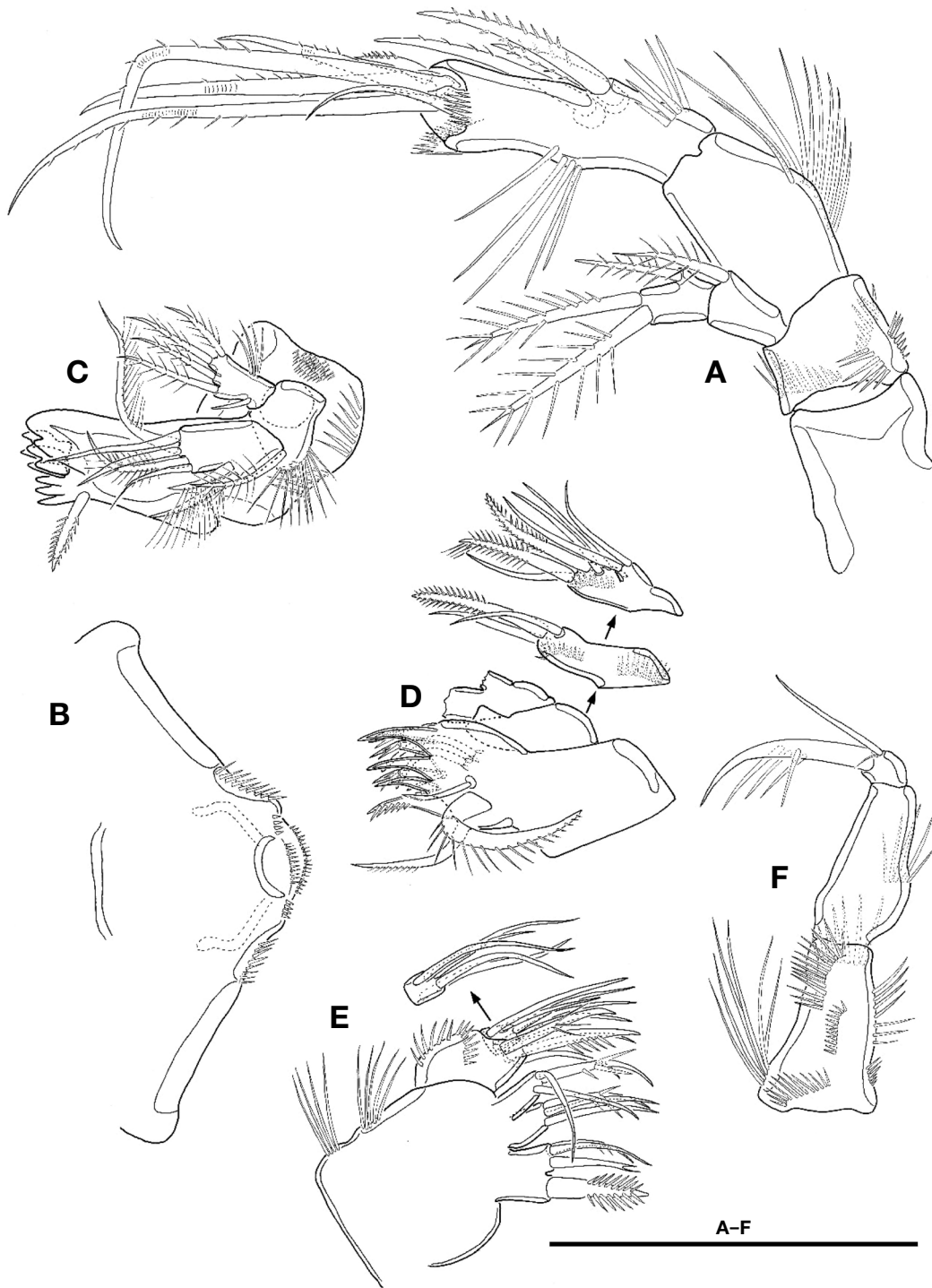
Korean name: <sup>1</sup>\*조막마디날래장수노벌레 (신칭)



**Fig. 1.** *Microarthridion littorale*, female (A, B, NIBRIV0000470365). A, Habitus, dorsal; B, Habitus, lateral. Scale bar: A, B=100  $\mu$ m.



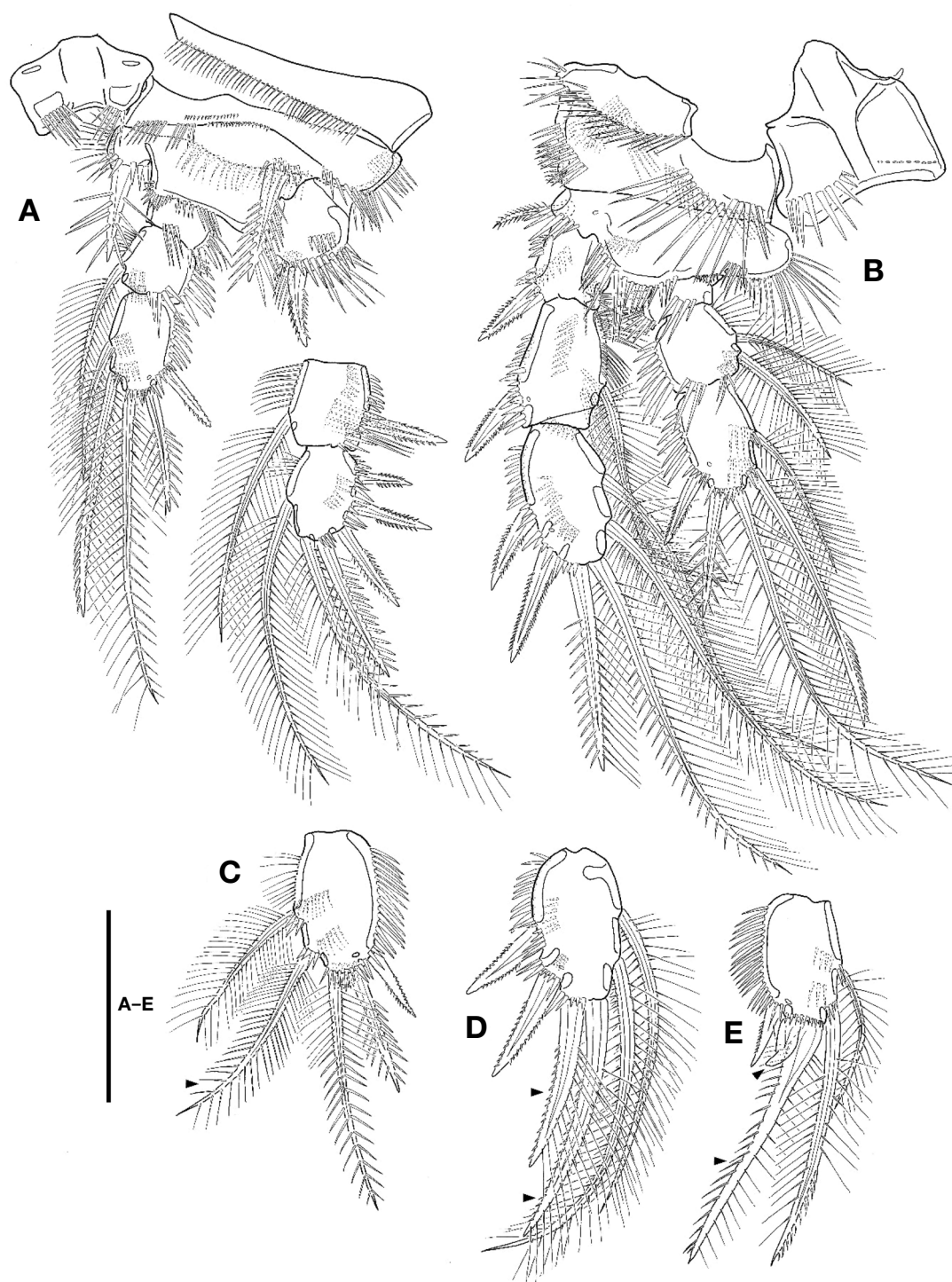
**Fig. 2.** *Microarthridion littorale*, female (A–F, NIBRIV0000470365). A, Rostrum; B, Urosome, ventral; C, Genital field; D, Caudal ramus, ventral; E, Caudal ramus, dorsal; F, Antennule. Scale bars: A, C–F=50  $\mu$ m, B=100  $\mu$ m.



**Fig. 3.** *Microarthridion littorale*, female (A, C, E, F, NIBRIV0000470365; B, D, NIBRIV0000470370). A, Antenna; B, Labrum; C, Mandible; D, Maxillule; E, Maxilla; F, Maxilliped. Scale bar: A-F=50  $\mu$ m.

largest, with 1 pinnate seta and 4 oblique rows of spinules; segments 2 with 1 minute bare and 6 pinnate setae; segment 3 with 4 pinnate setae; segment 4 smallest, with 1 pinnate

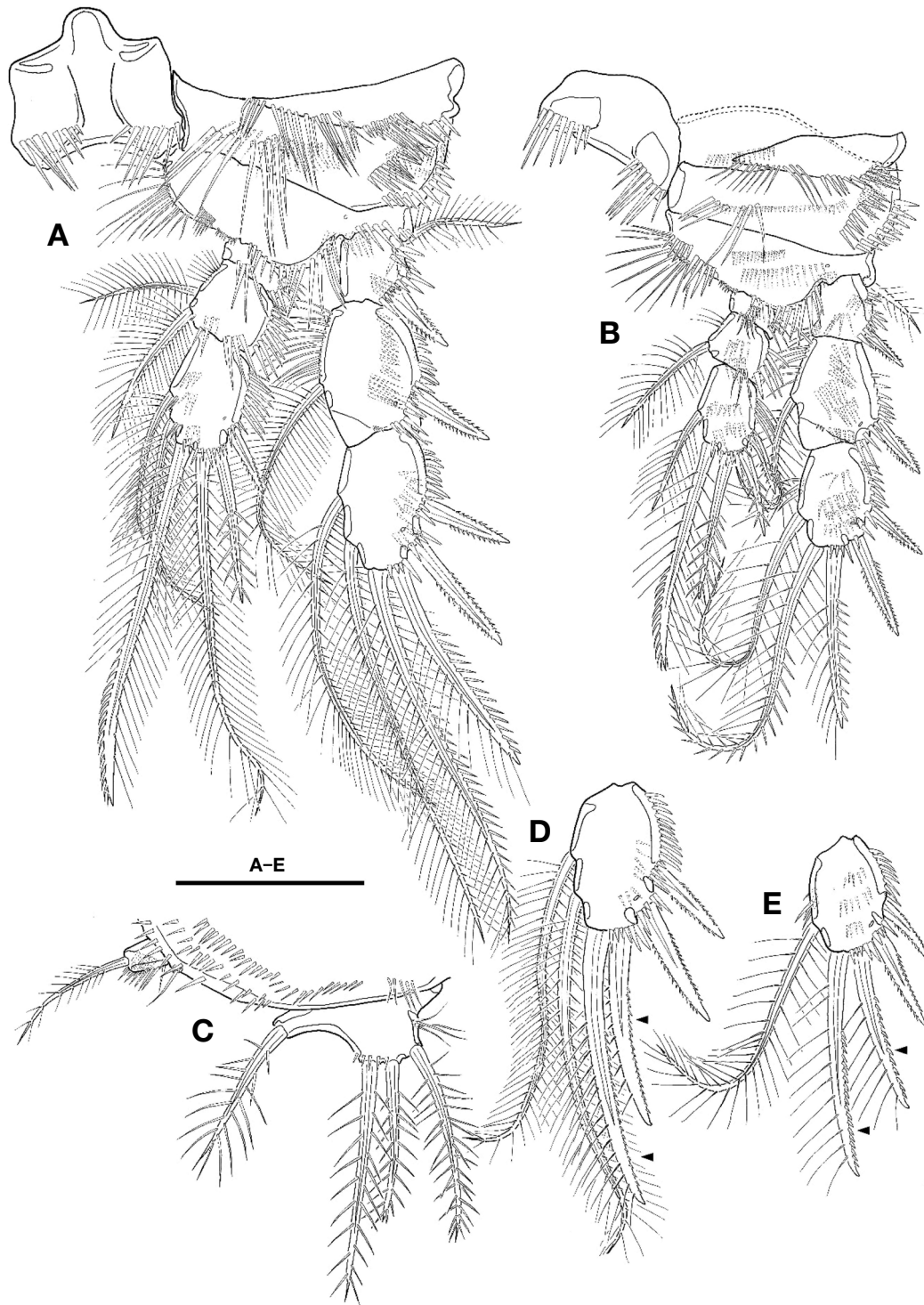
seta and 1 peduncle having aesthetasc and long pinnate seta; segment 5 small, with 1 pinnate seta; segment 6 blunt, as long as two preceding segments combined, and bearing 1



**Fig. 4.** *Microarthridion littorale*, female (A, B, NIBRIV0000470365): A, P1; B, P2. Male (C, NIBRIV0000470368; D, E, NIBRIV0000470366): C, P1 enp-3; D, P2 exp-3; E, P2 enp-3. Arrows indicate sexual dimorphism in male. Scale bar: A-E=50  $\mu$ m.

plumose seta, 6 bare setae, 7 pinnate setae, and 1 aesthetasc. Each aesthetasc on segments 4 and 6 fused to pinnate seta at its base.

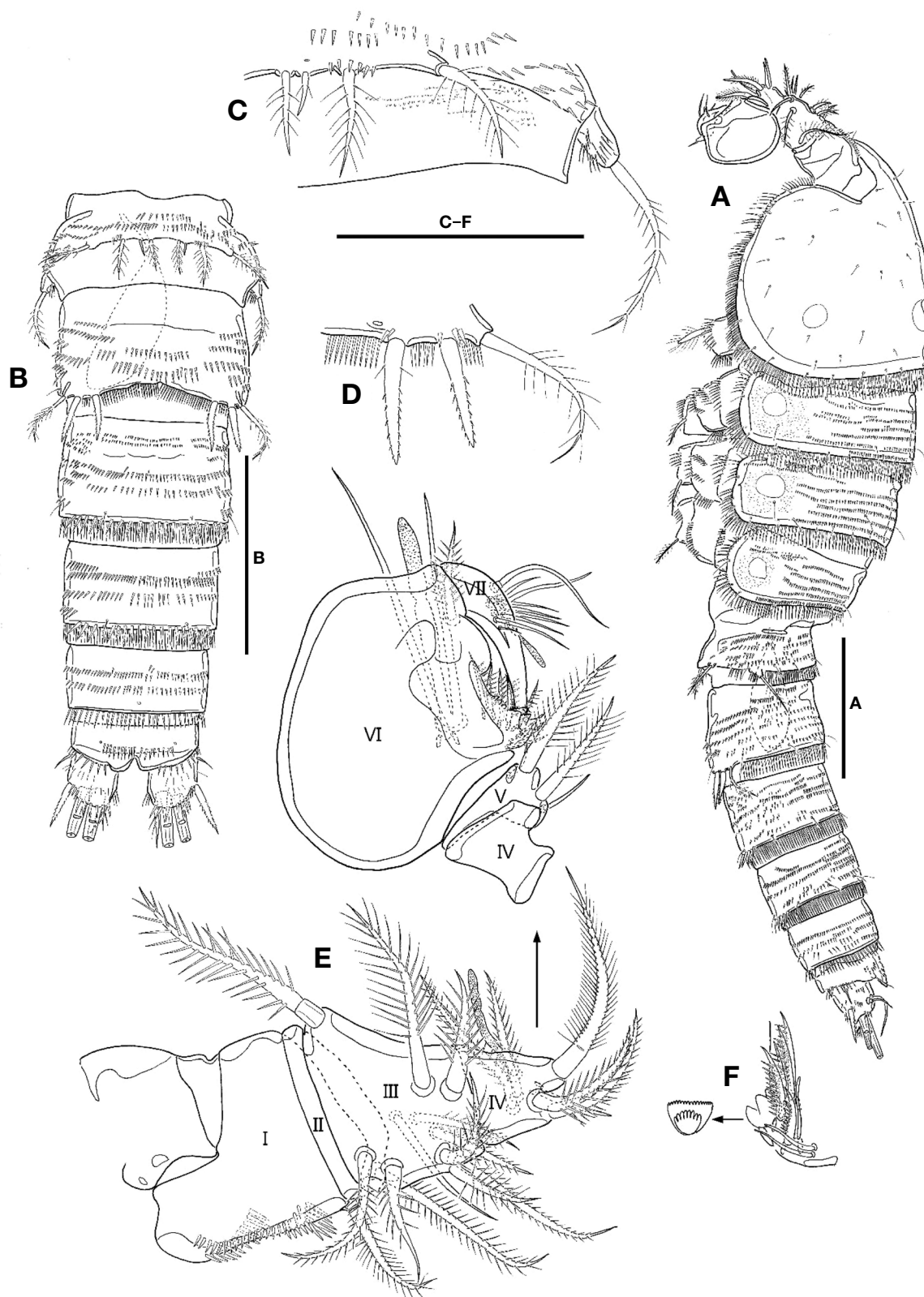
Antenna (Fig. 3A). Coxa without ornamentation. Basis small, shorter than coxa, with 4 rows of spinules. Exopod 2-segmented; proximal segment with 1 plumose seta at dis-



**Fig. 5.** *Microarthridion littorale*, female (A-C, NIBRIV0000470365): A, P3; B, P4; C, P5. Male (D, E, NIBRIV0000470366): D, P3 exp-3; E, P4 exp-3. Arrows indicate sexual dimorphism in male. Scale bar: A-E = 50  $\mu$ m.

tal corner; distal segment slightly shorter than preceding one, with 1 lateral and 2 apical plumose setae. Endopod 2-segmented; proximal segment about 2 times as long as

coxa, with 1 row of setules along abexopodal margin; distal segment longer and slender than preceding one, with 1 row of setules on inner margin, 1 row of spinules proximally



**Fig. 6.** *Microarthridion littorale*, male (A-D, F, NIBRIV0000470366; E, NIBRIV0000470368). A, Habitus, lateral; B, Urosome, ventral; C, P5; D, P6; E, Antennule; F, Proximal of palmar margin on sixth antennular segment. Scale bars: A, B=100  $\mu$ m, C-F=50  $\mu$ m.

and 3 pinnate spines on abexopodal margin, and 2 hyaline frills on distal margin; distal armature of distal segment composed of 1 small pinnate spine, 4 geniculate setae, and 1 small bare seta.

Labrum (Fig. 3B) well-developed, armed with paired spinular row along lateral margin distally, and 2 spinule rows and 1 paired spinule rows near distal margin.

Mandible (Fig. 3C). Gnathobase well-developed, with 1 tricuspid, 1 bicuspid, and 5 unicuspid teeth on cutting edge and 1 pinnate seta at distal corner; surface with 2 rows of setules and patch of small spinules. Palp biramus; basis broad, with 1 plumose seta and 1 row of spinules; exopod 1-segmented, small, with 1 bare and 4 plumose setae and 1 group of setules; endopod 1-segmented, elongate, with 2 uniplumose setae on lateral margin and 3 bare and 2 plumose setae on distal margin.

Maxillule (Fig. 3D). Praecoxal arthrite with 7 spines (3 naked, 3 bearing spinule, and 1 pinnate) and 4 setae (2 stout unipinnate, 1 small naked, and 1 small unipinnate); anterior surface with 2 juxtaposed setae. Coxa with 2 rows of spinules on anterior surface; endite with 1 stout pinnate and 2 bare setae. Basis with 1 row of spinules on anterior surface, 2 stout pinnate and 3 bare setae. Endopod small, 1-segmented, fused into basis at its base, with 2 apical setae. Exopod absent.

Maxilla (Fig. 3E). Syncoxa with 2 rows of setules along outer margin and 3 endites; proximal endite bilobate, with 1 stout pinnate seta on proximal lobate and 3 setae on distal lobate; both middle and distal endites each with 1 spinulose and 2 bare setae. Allobasis with 2 rows of spinules and bearing 2 spinulose and 2 bare setae. Endopod 1-segmented, small, with 5 elements.

Maxilliped (Fig. 3F) 3-segmented, subchelate. Syncoxa elongate with 6 rows of spinules and 1 group of long setules. Basis as long as coxa, with 1 row of setules near middle of outer margin. Endopod 1-segmented, small, with 1 long and 1 very small setae, and 1 long claw bearing accessory spinules.

P1 (Fig. 4A). Intercoxal plate bilobate distally, with 1 row of spinules on each side. Praecoxal well-developed, with row of setules along distal margin. Coxa small, with 1 rows of small spinules on anterior surface and 3 rows of minute or moderate spinules along distal margin; outer margin with 2 rows of spinules posteriorly; distal margin with posteriorly 1 row of setules. Basis larger than coxa; inner spines spinulose, with spinules near its base; outer spine spinulose distally, with spinules near its base; inner margin with 1 row of setules; distal margin with 1 row of spinules. Exopod 3-segmented, longer than endopod, armed with several rows of spinules; exp-1 with 1 outer pinnate spine; exp-2 with 1 outer spine and 1 inner plumose seta;

exp-3 with 3 outer spines, 2 apical setae, and 1 inner seta. Endopod 3-segmented, armed with several rows of spinules; enp-1 small, without inner seta; enp-2 with 1 inner plumose seta, 1 setule row on inner margin; enp-3 elongate, with 1 outer spine, 2 apical and 2 inner setae.

P2–P4 (Figs. 4B, 5A, B). Intercoxal plate armed with 2 spinule rows on anterior surface distally. Praecoxa smaller than that of P1, armed with rows of spinules distally. Coxa larger than that of P1; anterior surface with 1 long setule row and 1 spinule row; posterior surface with 2 or 3 spinular rows and 1 minute setule group; outer margin with 1 row of spinules. Basis with 1 plumose outer seta; anterior surface with 1 or 2 spinules distally and 1 pore; posterior surface with 1 or 3 spinule rows; inner margin with 1 row of long setules; distal margin armed with 2 or 3 spinule rows. Both rami 3-segmented, armed with several rows of spinules; exopod longer than endopod; exp-2 with 1 inner setule row and 1 anterior pore; exp-3 with anterior pore; enp-1 small, with row of spinules on anterior surface; enp-2 with 1 setule row on inner margin; enp-3 with 1 tube pore on anterior surface except for P4; distal seta on enp-3 serrate distally. Setal formula of P2–P4 as follows:

	Exopod	Endopod
P2	0.1.222	0.2.221
P3	0.1.222	0.2.321
P4	0.1.122	0.1.221

P5 (Fig. 5C) fused to somite. Outer peduncle located on lateral surface, armed with 2 rows of spinules, bearing 1 plumose apical seta. Exopod and baseoendopod fused, forming bilobate sling plate; outer lobe small with 1 plumose seta; inner lobe large, with 3 long plumose setae and 1 group of inner setules.

**Male:** Body shape and ornamentation similar to female (Fig. 6A); total length from 666.7 to 712.2  $\mu\text{m}$  (mean 689.5,  $n=2$ ) including rostrum and caudal rami; urosomites 2 and 3 separated each other (Fig. 6B).

Antennule (Fig. 6E, F) 7-segmented, blunt, and subchelate. Segment 1 with 1 plumose seta and 4 rows of spinules. Segment 2 very short, with 1 plumose seta. Segment 3 tapering distally, with 10 plumose or spinulose setae and 1 naked seta. Segment 4 with 5 plumose or spinulose setae, 1 naked seta, and 1 small aesthetasc. Segment 5 small, subtriangular in shape, with 2 plumose and 1 naked setae. Segment 6 large, swollen; palmar margin with 3 naked and 5 unipinnate setae, 3 small produces and 1 bub-like process; inner surface having 2 slender setae and 1 aesthetasc; distal corner with 1 spinulose seta; aesthetasc on inner surface fused to seta at its base; distal margin of bub-like process serrate in ventral view (Fig. 6F). Segment 7 hook-shaped, slender, with 9 bare setae and 1 aesthetasc.

P1 as female except for distal inner seta on enp-3, which plumose, not pinnate distally (Fig. 4C).

P2 as female except for exp-3 and enp-3. Two apical setae on exp-3 modified; outer margin of apical setae armed with very small spinules; inner seta on smaller that of female (Fig. 4D). Enp-3 with modified apical setae; outer seta very reduced, slightly curved outwardly; inner seta shorter than that of female, slightly swollen at its base (Fig. 4E).

P3 and P4 with modified apical seta on exp-3; outer margin of apical setae armed with very small spinules; inner apical seta on exp-3 smaller that of female (Fig. 5D, E).

P5 (Fig. 6C) incorporated into P5-bearing somite. Endopodal lobe weakly developed, small plate-like, and with 4 setae; second inner seta shortest. Outer peduncle separate from endopodal lobe, located on lateral surface, with long plumose apical seta.

P6 (Fig. 6D) symmetrical, represented by plate; each with 2 pinnate spines and 1 long plumose seta.

**Remarks.** The Korean specimens examined in the present study are herein attributed to *M. littorale* (Poppe, 1881) in the following diagnostic features for females: 6-segmented antennule, antennary exopod with four setae totally, P1 enp-3 with five setae, P2–P3 enp-2 with two setae, respectively, and P5 represented by a single plate bearing four plumose setae (Boxshall and Halsey, 2004; Kihara and Rocha, 2007; Tran and Chang, 2012). However, our specimens differ from the representative records of *M. littorale* (Poppe, 1881; Scott, 1892; Gurney, 1932; Borutsky, 1952; Tai and Song, 1979; Huys et al., 1996) by the following: (1) the maxillipedal syncoxa is armed with six groups of spinules and one group of long setules, while it is ornamented with only two rows of spinules in the records of Poppe (1881) and Gurney (1932); (2) the maxillipedal endopod has one long and one very small accessory setae, whereas it is armed with only one long seta in the materials of previous records; (3) both anterior and posterior surfaces of the swimming legs are armed with several rows of setules or spinules, while these ornamentations are absent or simple in previous records; (4) the distal inner setae on enp-3 of the swimming legs are distally serrate, whereas it is plumose in previous records; (5) the inner apical seta of P2 enp-3 in males is slightly swollen at its proximal, while it is not expanded in the records of Gurney (1932) or Huys et al. (1996). These morphological details hitherto have not been considered as key characters to identify *Microarthridion* species, although detailed features such as body ornamentation pattern, pores and sensilla pattern, and the feature of the setae on swimming legs have been noticed as characteristic features in modern harpacticoid taxonomy (Huy et al., 2005; Kihara and Huys, 2009; Karanovic and Cho, 2012; Fiers and Kotwicki, 2013).

For male *M. littorale*, the Korean materials typically dis-

play well known sexual dimorphism of the genus with the outer apical seta of P2 enp-3 remarkably reduced (Fig. 4E). In addition, for the first time, sexual dimorphisms in swimming legs were observed from these Korean materials of *M. littorale*. The distal inner seta on P1 enp-3 is distally serrate in females, while it is plumose in males (Fig. 4C). The two apical setae (Figs. 4D, 5D, E) on exp-3 of P2–P4, inner one of which is decreasing in length, are modified with size reduction of the outer spinules in the males. Such modification of the apical setae is not present in the females.

## DISCUSSION

### Taxonomic notes and detailed morphological diversity of so-called *Microarthridion littorale*

*Microarthridion littorale* Poppe (1881) is euryhaline with a wide distribution, ranging from estuarine to shallow subtidal localities (Huys et al., 1996). It has been found in Europe, North America, and East Asia (Chang, 2008). However, taxonomical records (Poppe, 1881; Scott, 1892; Gurney, 1932; Borutsky, 1952; Tai and Song, 1979; Huys et al., 1996) of this species are ambiguous in details. They represent some discords from each other in the following characters:

(1) The female *M. littorale* from Norway was about 750  $\mu\text{m}$  long in the original description of Poppe (1881). However, the females from British and Chinese waters were smaller in sizes (Gurney, 1932; Tai and Song, 1979). The sizes of Gurney's (1932) materials ranged from 450 to 570  $\mu\text{m}$  in the females and from 400 to 460  $\mu\text{m}$  in the males. The sizes of Tai and Song's (1979) specimens ranged from 420 to 620  $\mu\text{m}$  in the females. On the other hand, the males of larger size (about 680  $\mu\text{m}$  in body length) were described from British waters by Huys et al. (1996).

(2) *Microarthridion littorale* has 6-segmented antennule. Such segmentation of the antennule in the females is considered as an important identification key for *Microarthridion* species (Boxshall and Halsey, 2004; Kihara and Rocha, 2007; Tran and Chang, 2012). However, discrepancy of antennular segmentation is known among species reported as *M. littorale*. Borutsky (1952) has described that the antennule was composed of seven segments for his Russian materials of *M. littorale*, although he presented 6-segmented antennule in his figure (see the position of the first antennular segment in Borutsky, 1952, fig. 36:1). On the other hand, Chinese specimens of Tai and Song (1979) appear to have 5-segmented antennule (see the position of the segment with one seta in Tai and Song, 1979, fig. 92B). It has been reported that harpacticoid species commonly bear only one seta on the first antennular segment (Huys and Boxshall, 1991). However, the Chinese materials were described to have an antennule

bearing a seta on the second segment among six antennular segments (Tai and Song, 1979). They might have mistakenly considered the base of the antennule as the first antennular segment. It is highly possible that they have mislabeled the position of the first segment among six antennular segments in their illustration.

(3) It is generally known that the second innermost seta on the female P5 is as long as the neighboring setae in *M. littorale* (Poppe, 1881; Scott, 1892; Gurney, 1932). The Korean materials of the present study also have the same feature. However, the seta in the materials of *M. littorale* from China and Russia was smaller in length (about half) compared to other neighboring setae (Borutsky, 1952; Tai and Song, 1979).

(4) Morphological differences between the previous records of *M. littorale* are also found in the armatures of the antennule, antenna, and mouth appendages and in the ornamentation of the swimming legs. However, these discrepancies might be due to observational errors or poor descriptions by the previous authors. It is well known that such incomplete descriptions from the oldest records can increase taxonomic confusion on most harpacticoid taxa, including Ectinosomatidae Sars, 1903 (Kihara and Huys, 2009).

These discrepancies in detailed morphological features might be mainly caused by poor and brief descriptions as mentioned above. Among so-called *M. littorale*, nevertheless, *M. littorale* sensu Tai and Song (1979) from China is probably a species distinct from *Microarthridion littorale* (Poppe, 1881) based on its small body size, the segmentation of antennule, and the length of the second inner seta on female P5 endopodal lobe. If those Chinese specimens indeed have 5-segmented antennule, they should not be coincided as *M. littorale* (Poppe, 1881) because the segmentation of the antennule is presently considered as an important identification key in the taxonomy of the genus (Kihara and Rocha, 2007; Tran and Chang, 2012). However, the real meaning of these morphological discrepancies merit further study with materials from China, Europe, and other regions.

*Microarthridion littorale* reported from north-west Europe, North America, and East Asia (Huys et al., 1996; Chang, 2008). Schizas et al. (1999) have reported that *M. littorale* populations along the southeastern Atlantic and Gulf of Mexico coasts of the U.S.A are structured over large geographic scales (hundreds of kilometers) based on molecular data. Considering the existence of morphological discrepancies among regional populations as mentioned above, these results suggest that many new species are probably situated under the name of *M. littorale*. Recently, Fiers and Kotwicki (2013) have revealed that there are differences among specimens from several regions on Europe attributed to *Nannopus palustris* Brady, 1880 which is known to have a worldwide

distribution. As a result, they have introduced four new species and one new combination by detailed morphological study. Therefore, a revision for so-called *M. littorale* is urgently needed. The present study could provide basic information for such study.

## ACKNOWLEDGMENTS

This study was supported by the research funds from Chosun University (2015) and the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR201501201), and partly supported by the National Marine Biodiversity Institute of Korea as a part of the 'Basic Research for Systematic Management of Marine Bioresources (2016M00300)'.

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Received June 13, 2016  
Revised July 4, 2016  
Accepted July 14, 2016